

Analysis of Technical Alternative Technologies for the Development of Context-Driven, Composable Environmental Representations for JSB

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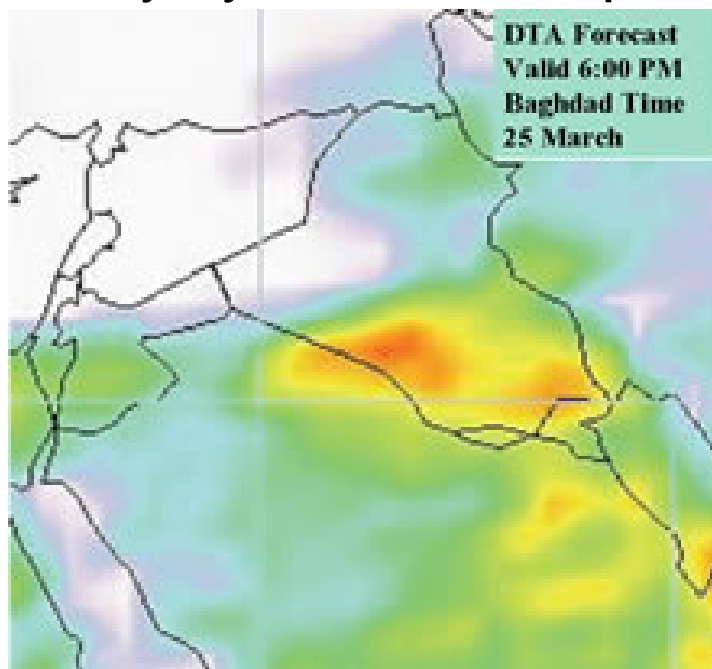
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The “Real World” Problem and Why is it Important?

- The environment can, and does, have a major impact on military systems and operations.



The “M&S World” Problem

- In M&S applications, the need exists to be able to:
 - a) Create environmental databases quickly and
 - b) Serve them up for simulations supporting theater commanders and operations
- How to satisfy these needs, that is the question!



State of the Art in Defining, Generating, and Providing Authoritative Representations – Data Shortfalls

- Operational providers exist that can generate authoritative environmental data, but shortfalls exist in two areas:
 - Atmospheric aerosols
 - Material properties for terrain databases
- Aerosol data shortfalls can be addressed using AFRL-developed aerosol models and smart inferencing
- The material properties shortfall can be addressed by developing “Material Code Attribute Terrain Databases (MCAT-DB)”



Procedures/Tools to Make Material Code Attributed Terrain Databases (MCAT-DB)

- Physics-based phenomenologies need to ingest Material Code Attributed Databases to produce meaningful results
- The need is to create these databases quickly for simulations
- Material Classifier Input:
 - Hyperspectral data
 - Multi-spectral data
 - RGB data
- Material Classifier Output: Material encoded mappings
- Extrude material encoded data into 3-D or merge with existing terrain databases

Output:

- Material encoded mappings

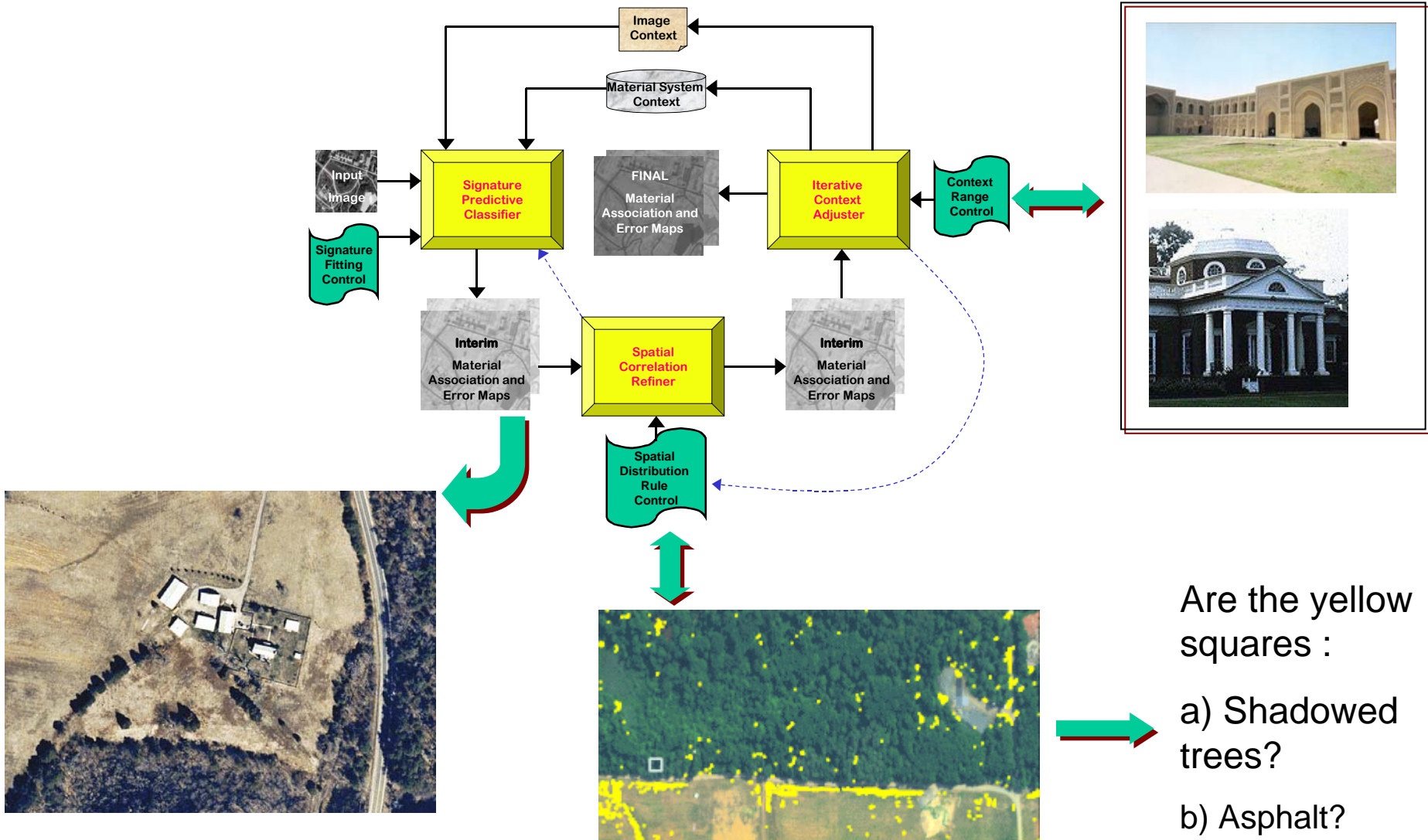


State-of-the-Art in Procedures and Tools to Create Material Code Attributed Terrain Databases (MCAT-DB)

- ImageMapper Problems:
 - Manual assignment of materials
 - Limited to three channels or fewer in input data
 - Color variation of a pixel does not take into account context: shadowing, surface normal, spectral DHR, etc.
 - No atmosphere or sensor effects corrections
- ENVI Problems:
 - Same issues as ImageMapper, but can handle hyper-spectral images
 - No support for thermal hyper-spectral or SAR-image



Material Classifier: Procedures and Tools to Make MCAT-DB



Myths and Realities on Providing Environmental Representation in M&S Applications

- **Myth:** Including an environmental representation in M&S applications is *Hard* because the environment is “Too Big”
- **Reality:**
 - The requirements of the simulation will determine the degree of difficulty required to incorporate any subject domain
 - Any subject domain entity can require a degree of fidelity that can tax a simulation’s resources (e.g., fine spatial resolution, small temporal resolution, first principles physics required)
 - Just because the playbox is “BIG” does not necessarily mean that the environmental representation required must be “BIG”



Myths and Realities on Providing Environmental Representation in M&S Applications

- **Myth:** Including an environmental representation in M&S applications involves unique simulation requirements
- **Reality:** There are no unique simulation requirements for including environmental representation in M&S applications
 - Any subject domain entity can be created with a large # of elements requiring distribution among the simulation
 - All transmission protocol mechanisms (e.g., RTI, DIS,...) transmit “1’s” and “0’s” and do not know (or care) if a “1 or 0” is an environmental datum or not



Myths and Realities on Providing Environmental Representation in M&S Applications

- **Myth:** The “real world” environment is constantly changing, so the “simulated” environment must also be updated on a frequent basis
- **Reality:** The nature of how entities interact with the environment will determine how often they need to “know” anything about the state of the environment
 - An entity (e.g., an airplane) does not know (or even care) that the environment exists until it performs an action that involves the environment (i.e., sense, shoot, land,...)
 - An entity (generally) does not care that the environment changes over time, but only if those changes significantly impact the environmental performance of the entity (i.e., a critical event occurs or a threshold is crossed)



Observations on How Environment Representations Have Been Provided in Past M&S Applications

- There are two basic approaches which are being used to provide environmental representation – servers and integrating frameworks
- The currently available environmental server (e.g., OASES) is based on legacy concepts from the STOW program using IEEE 1278.1a-1998 environmental protocol data units that were designed to be “pushed” out over a distributed network



Observations on How Environment Representations Have Been Provided in Past M&S Applications (Cont.)

- Integrating frameworks are used to provide environmental data, effects, and dynamic feedbacks between environmental components and other simulation entities
- A number of environmental integrating frameworks have been developed by USA Corps of Engineer, Department of Energy, US Environmental Protection Agency, US Department of Agriculture, and US Geological Survey



Recommendations on How Environment Services Should be Provided to M&S Applications

- The details of how the environmental services are provided in an M&S application should be driven by the requirements of the applications being served, such as:
 - Provide data or effects,
 - “Push” or “pull” service mechanism, and
 - Runtime or predistribution of data/effects
- Sensitivity analyses of the relevant physics or processes (e.g. operational doctrine) important in the application can be used to determine a “common sense” assessment of the environmental spatial and temporal requirements



Recommendations on How Environment Services Should be Provided to M&S Applications (Cont.)

- Have an environmental “black box” that can provide data and/or effects in a context-driven manner – driven by the *specific* simulation needs of the interacting entities
- The requirements of the simulation’s entities would detail:
 - How they get the data (push or pull)
 - When they get the data
 - Where they get the data
 - The format of the data
- The resulting system should be reconfigurable to meet the dynamic needs of M&S applications



What is Needed is an Integrated Dynamic Environmental Architecture

- **Why Integrated?** The different environmental domains are linked by physics in the “real” and simulated worlds
- **Why Dynamic?**
 - In the “real” (and simulated) world, the environmental requirements for systems will change during the course of a mission as different mission phases are executed (e.g., launch, way points, refueling, ...)
 - In a synthetic environment, the same set of simulation entities can have different environmental requirements depending on the “composition” of the simulation context



Components of the Integrated Dynamic Environmental Architecture (IDEA)

- The *IDEA* will be built using the dynamic information architecture system (DIAS) object-oriented simulation framework
- DIAS is a proven, patented, and *government-owned* simulation framework



**Integrated Ocean
Architecture for Joint
Maritime Operations**



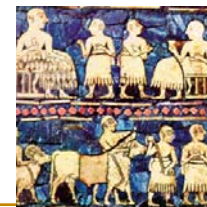
**Integrated land
management and
planning for DoD
training bases**



**Integrated
physiological, clinical
and logistical
simulations**



**Analysis of counter
drug interdiction
strategies**

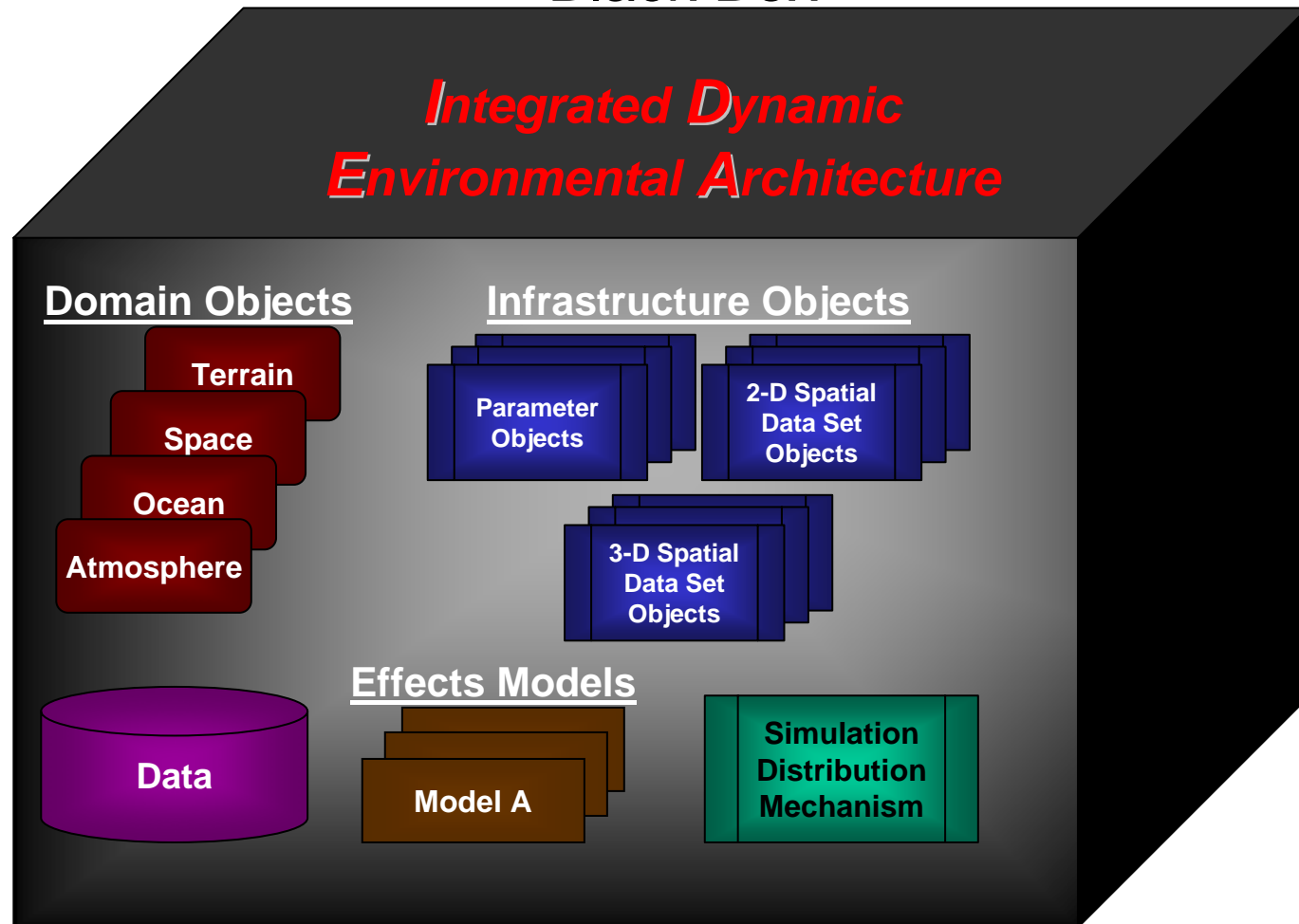


**Agricultural and
social sustainability
of ancient urban
centers**

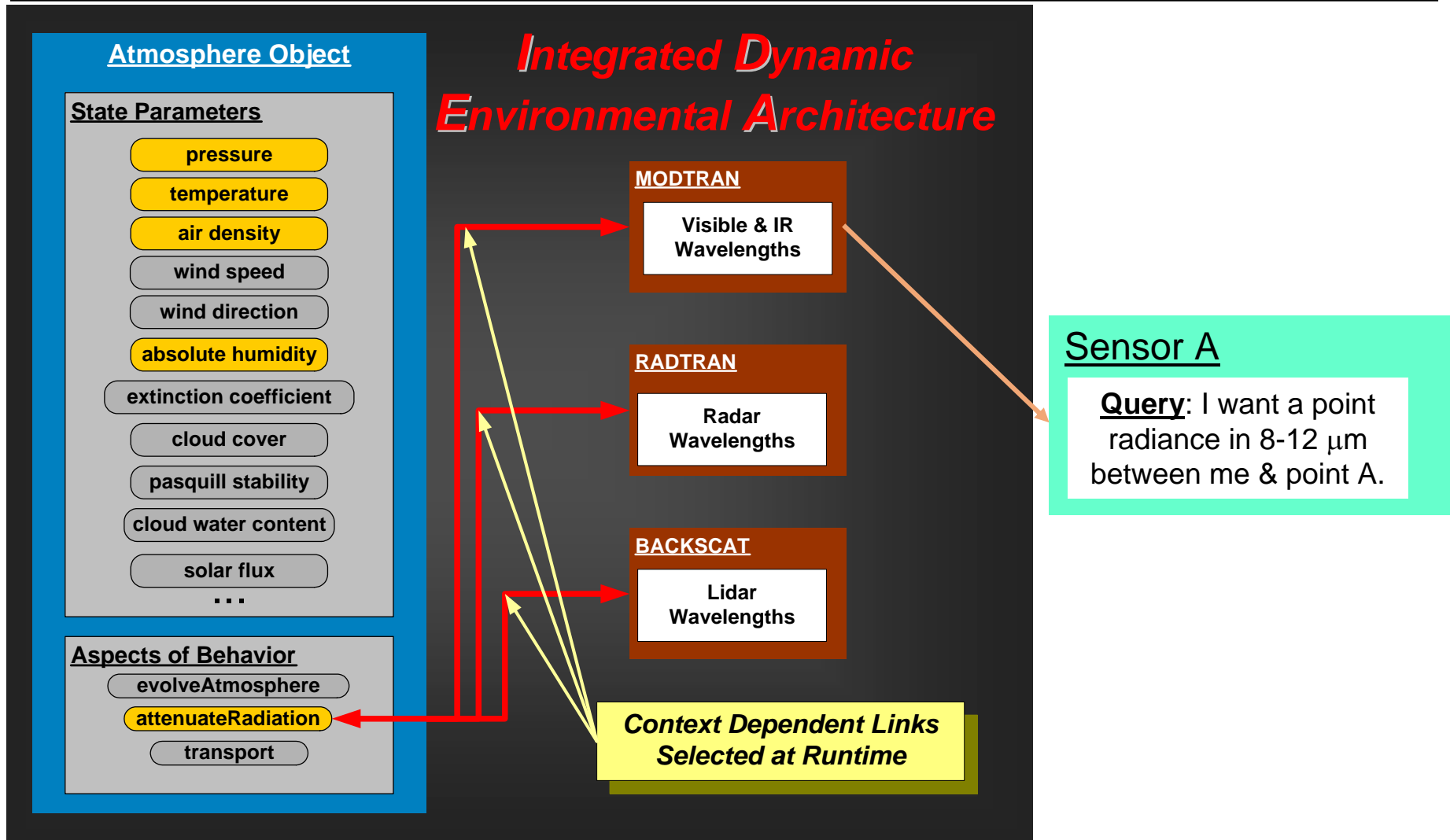


Components of the Integrated Dynamic Environmental Architecture

The *IDEA* Concept Starts by Treating the Environment as a “Black Box”



How can an IDEA Provide Context-Driven Support to M&S Applications?



Summary

- Current and future DoD M&S applications have environmental requirements that **will vary** from application to application in terms of:
 - The types and resolutions of data/effects that will be needed,
 - If the data/effects need to be distributed and how, and
 - How runtime services are implemented (push or pull)
- Concepts have been developed to rapidly create Material Code Attribute Terrain Databases and make them, and other environmental data and effects, accessible via an Integrated Dynamic Environmental Architecture

